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ABSTRACT

This document highlights what is needed to ensure excellence in mathematics education as teachers and schools prepare students for the world beyond the classroom. One goal of this publication is to inform parent groups, school boards, business leaders, and local policy makers of the changes taking place in mathematics education. The purpose of a strong foundation in mathematics is stated and a description of a modern mathematics classroom with a problem solving flowchart are included. A brief discussion of the standards of the National Council of Teachers of Mathematics (NCTM) for curriculum, teaching, and assessment is provided. Specific changes in educational practice produced by adherence to NCTM standards are listed. Visible signs of change in classrooms, teachers, students, homework, tests, and grades are also described. (DDR)

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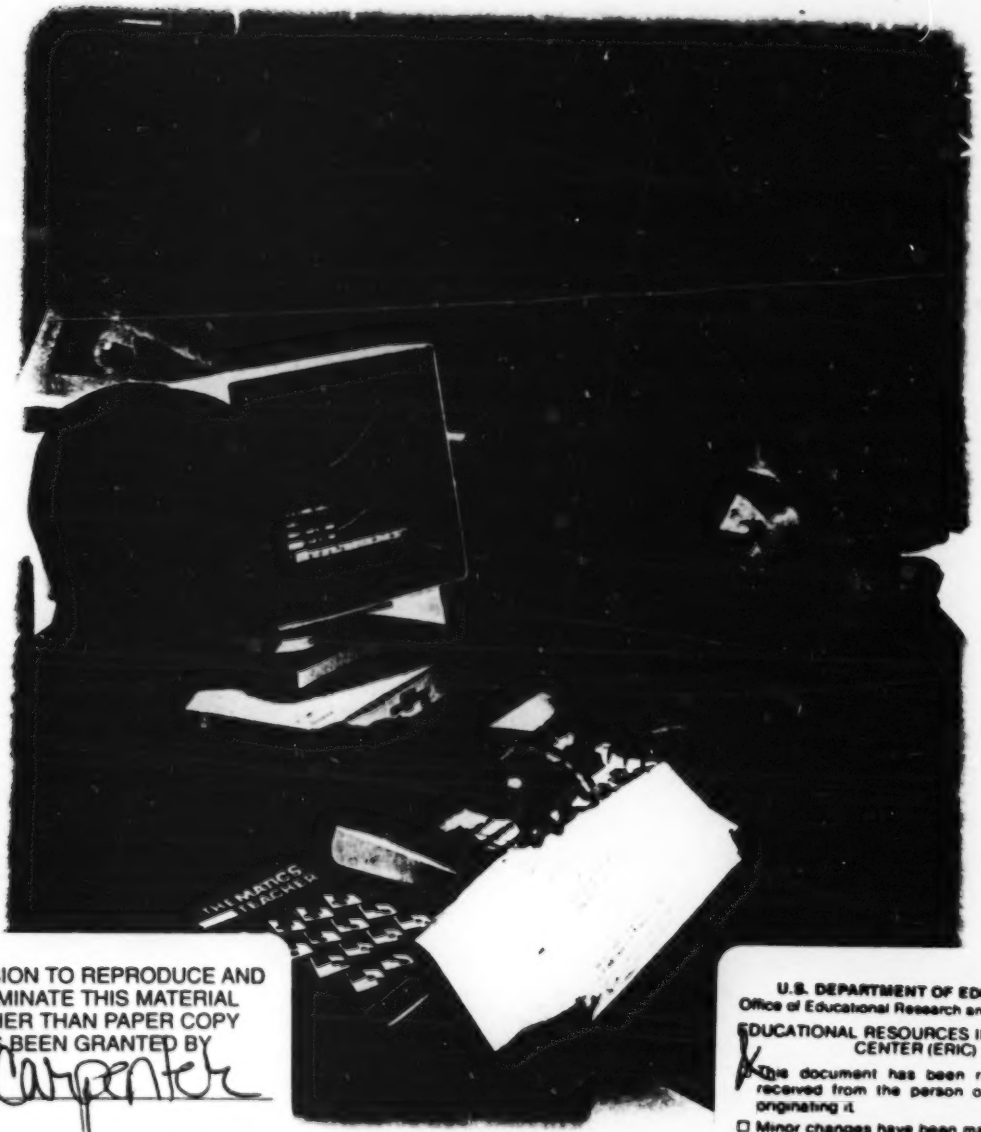
MATHEMATICS

MAKING A LIVING, MAKING A LIFE



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Dear Colleague:

The National Council of Teachers of Mathematics (NCTM) is pleased to give you this complimentary copy of *Mathematics: Making a Living, Making a Life*. This document highlights what is needed to ensure excellence in mathematics education as teachers and schools prepare students for the world beyond the classroom walls.

***Mathematics: Making a Living, Making a Life* is a means to inform the community of the changes taking place in mathematics education. Parent groups, school boards, business leaders, and local policymakers may find the brochure insightful and informative. By reaching all those with an interest in mathematics education, we can strengthen our efforts to ensure high-quality mathematics education for all students.**

NCTM's *Mathematics: An Introduction to the NCTM Standards*, a companion piece to *Mathematics: Making a Living, Making a Life*, offers a more in-depth look into the NCTM *Standards*. Written with the mathematics educator in mind, it is the perfect handout for teacher in-service meetings.

This complimentary copy of *Mathematics: Making a Living, Making a Life* is just one of the many benefits of membership in the NCTM. With your help, we can improve mathematics education for all children.

Sincerely,

Gail F. Burrill

Gail F. Burrill
President

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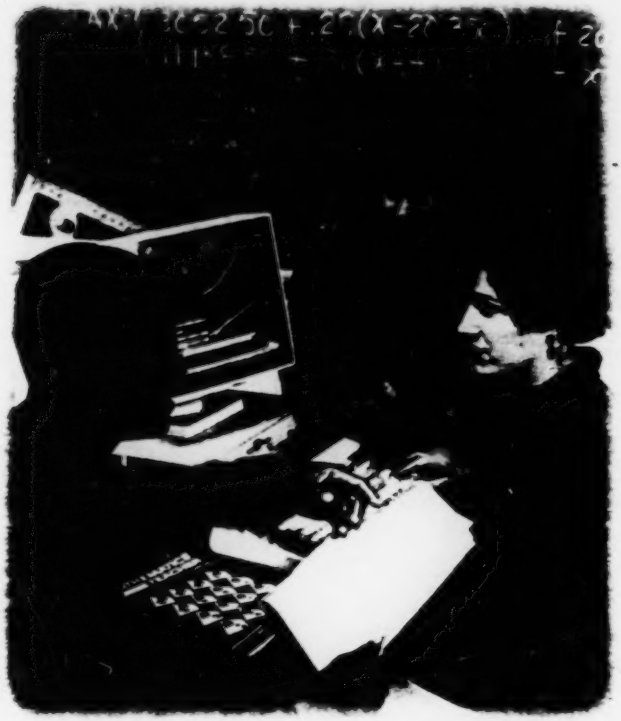

University of South Carolina/ISC

A GUIDE TO MATHEMATICS EDUCATION TODAY

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NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS

THE PURPOSE...

...of an education, a prominent educator once said, is to teach students how to make a living and how to make a life. Children are ill-equipped to do either without a fundamental knowledge of the mathematical skills and ideas that are the foundation of our world. For far too long, far too many students have not connected the mathematics they study in school with the outside world. Their perception is that mathematics doesn't make sense.

To change that perception, the National Council of Teachers of Mathematics (NCTM) has described in three documents what mathematics students should know and be able to do, how they should be taught, and how their progress should be measured.

The documents on curriculum, teaching, and assessment present standards to guide efforts for a strong mathematical foundation that will equip students to meet future challenges. This foundation requires that—

- Students solve mathematical problems that go beyond arithmetic and algebra;
- Classrooms be environments in which students take an active role in the learning process; and
- Assessments be used to promote student learning and to assist teachers in making instructional decisions and in evaluating student achievement.

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Charleen Hernick, Bell Park Portrait Studio

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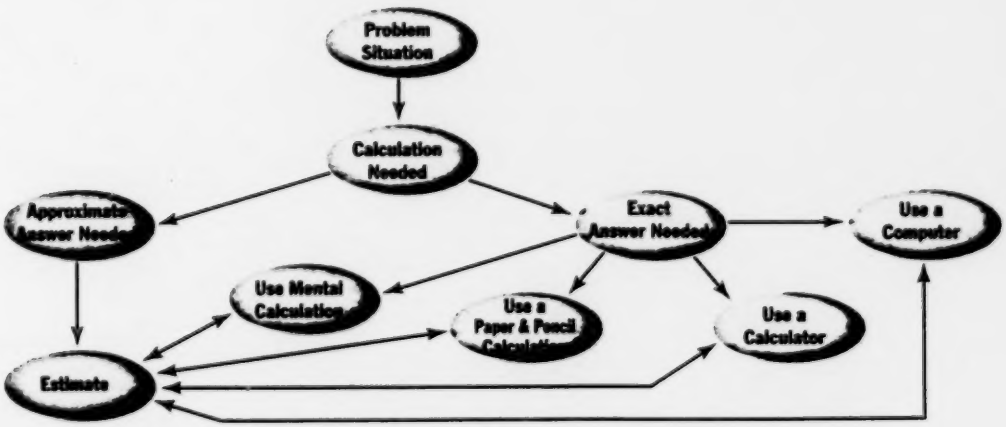
TODAY'S CLASSROOMS

Classrooms that are based on these standards probably differ from the classrooms most of us can recall. We may recall exercises that, if done successfully, pleased our teachers, but we do not recollect why we should have learned the exercises. We may remember tests for which we memorized procedures to earn high scores, but we forget the mathematics that was learned to pass the test.

Some of this failure to connect the classroom with the real world persists today. Decimals can be a difficult concept for some children to master. But many children who cannot work with decimals in the classroom can easily figure out the new batting averages of their baseball idols. They can tell you, after every game and before the averages are printed in the papers, what Ken Griffey, Jr., Robin Ventura, Barry Bonds, or Cal Ripken, Jr., are hitting. And many of them can do the calculations without even writing the numbers down. In this instance, it's clear that the world of the classroom and the world beyond the classroom walls are not connected.

When connections are made, mathematical skills develop more naturally. Sometimes, paper-and-pencil computation is best. Sometimes mental mathematics or an estimation will suffice. Other times, a computer or calculator is the best tool. Technology has changed the world and every aspect of our lives, including the study of mathematics. The simplest calculator can quickly add, subtract, multiply, and divide. Computers and sophisticated calculators can manipulate numbers, chart graphs, and collect and organize data in order to analyze mathematical models. They can make laborious tasks easy, help students master mathematical skills more quickly, and enable them to focus more on the why and what of mathematics than just on the how.



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STANDARDS

The curriculum, teaching, and assessment standards reflect this new technological world and the need for children to understand it better. The goals of these standards ultimately are to provide all children with an education in mathematics that will help them become more productive members of society and help them share in its benefits. In the process, the study of mathematics will become an exciting experience for both students and their teachers.

The NCTM's three sets of standards are:

- *Curriculum and Evaluation Standards for School Mathematics*, published in 1989;
- *Professional Standards for Teaching Mathematics*, published in 1991; and
- *Assessment Standards for School Mathematics*, published in 1995.

The standards are not intended to be step-by-step "how to do it" documents. Instead, they provide goals and principles against which curricula, instruction, and assessment practices can be examined. They are meant to stimulate policy makers, parents, teachers, administrators, and local communities and school boards to improve programs in mathematics at all educational levels.

Each set of standards was written by a team of NCTM members whose collective knowledge and professional responsibilities reflect the diversity of the membership of the Council.

National Education Association, Joe Didio

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These teams included classroom teachers, supervisors, educational researchers, professors of mathematics, and professors of mathematics education. Thousands of others, both NCTM members and nonmembers including parents and business leaders, reviewed and critiqued each document in draft form, so that the final versions represent a broad consensus.

The *Curriculum and Evaluation Standards for School Mathematics* describes the mathematics that all students should know and be able to do. The document is divided into grade levels K to 4, 5 to 8, and 9 to 12, each level having twelve to fourteen standards. These standards identify the basic skills and understandings students should have in numbers and number theory, geometry, measurement, probability and statistics, patterns and functions, discrete mathematics, algebra, and beyond. They also emphasize that students need to learn how to solve problems, reason, communicate mathematically, and connect their studies to other areas of mathematics, other disciplines, and the real world.

The *Professional Standards for Teaching Mathematics* illustrates ways that teachers can structure classroom activities so students can learn the mathematics described in the *Curriculum and Evaluation Standards*. These standards are organized around the fundamental decisions that teachers make: choosing meaningful

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mathematical tasks, establishing and promoting classroom discussion around these tasks, and creating an environment for learning.

In addition, the *Teaching Standards* provides principles for the professional development of mathematics teachers and for the evaluation of mathematics teaching. The document also describes the roles and responsibilities of administrators, school boards, and others in supporting teachers and the teaching of mathematics.

What do students know about mathematics and what kind of mathematics can they do? These are the most important questions that parents, teachers, potential employers, college admission officers, and the general public ask. Students also need to know how they are progressing. The *Assessment Standards for School Mathematics* contains the principles teachers and others should use to build assessment practices that support the development of mathematical power for all students.

These standards emphasize the need to use multiple sources of information about what students are learning. Tests alone are not enough. Other evidence of student progress may come from close observation, one-on-one discussions, and detailed examination of the work they do. In homework, for example, the process a student uses to reach an answer reveals important information to the teacher about the student's level of understanding.

Assessment should also promote equity. Teachers in exemplary classrooms have high expectations for all students, provide for different learning styles, and encourage the active involvement of all students in learning mathematics. Assessment must give each student, including those with special needs or talents, the opportunity to demonstrate his or her understanding in a variety of ways. Results of the assessments must be used to ensure that each student is given not only the opportunity but the necessary support to reach the highest possible levels of accomplishment.

CHANGES IN EDUCATIONAL PRACTICES

National Education Association, Joe Didio

These NCTM standards can produce several positive changes in schools and classrooms throughout the country:

- In curriculum, a shift toward a more extensive study of mathematical ideas and concepts and their uses in today's world;
- In learning, a shift toward more active student involvement with mathematics, including mathematical problems that relate to their world, and the use of a variety of mathematical tools for solving those problems;
- In teaching, a shift toward creating classrooms that are stimulating learning environments in which all students have the opportunity to reach their full mathematical potential; and
- In assessment practices, a shift toward student evaluations that are continuous and based on many sources of evidence.

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VISIBLE SIGNS OF CHANGE

Imagine that you revisit your elementary school or high school and observe a mathematics class that is following the NCTM standards. How would the class be different from your class ten or twenty years ago?

The Classroom. The classroom is not a passive environment, with the teacher at the chalkboard talking, and the students listening and doing exercises based on the lecture. Direct teaching is still used, but so are other approaches. Today, the desks are not always facing front because students may be clustered at times in small teams to work together, as done in business and industry, to solve problems or complete mathematical projects. There are computers around the room used by some students, and most students have calculators. The room will be noisier than you remember, but it is purposeful noise—the sounds of students involved in mathematical learning.

The Teacher. Although the teacher may at times lecture, he or she is no longer always in the front of the room. Depending on the mathematical task, the teacher may walk around the room, helping teams when they have questions, working individually with students, and, when necessary, clarifying ideas and concepts at the chalkboard or computer to small groups of students. In this role, the teacher becomes more of a mentor with a carefully crafted plan both to allow students to help one another and to allow the teacher to have the opportunity to spend time with individual students who need expert guidance. At all times, however, the teacher is responsible for setting high expectations and for organizing the classroom environment so that significant, high-quality mathematics learning can occur.

The Students. The students, too, take greater responsibility for their own learning and are challenged to meet higher expectations. In or outside classrooms, they engage in important mathematical tasks while interacting with the teacher, instructional materials and equipment, and each other. You can expect to see them struggling at times with challenging mathematical problems, but you can also expect to see their sense of accomplishment. They begin to see mathematics as a living discipline that they can understand rather than as a collection of rules they have to memorize for a test and then forget.

Homework. Homework assignments are more than sheets of arithmetical exercises where students just have to add, subtract, multiply, or divide. Instead, they are problems that students have to solve—problems that relate to their own lives and environments. For example, depending on their grade levels, students may be asked to respond to questions like these:

- How much food should be purchased for a school picnic?
- What is the average height of a fourth grader?

- How much lumber is needed to build a dog house?
- What do seashells, pine cones and sunflowers have in common mathematically?
- How can a car be accelerating even if it's slowing down?

Tests and Grades. Tests are no longer necessarily the end of a unit of learning. Depending on the results, teachers may decide to clarify certain portions of the material that were not well understood. Moreover, judgments about students' learning are not based solely on a few timed paper-and-pencil tests. Neither are grades. Instead, course grades reflect performance on projects, tests, classwork, and homework to furnish a more complete picture of students' understanding. Grades are only one way to report progress to students and parents. Other forms of reports, such as profiles or progress reports, may also be used.

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OUR CHALLENGE

NCTM's three *Standards* documents challenge those involved in the education of students to make a commitment to build systems and practices in which all students learn how to use mathematics effectively and confidently. This commitment includes an examination of whether teachers have both the tools and materials they need to teach effectively and the necessary support for their continued professional development.

Teachers cannot do it alone. Meeting the challenge of the NCTM *Standards* requires the active engagement, commitment, and efforts of parents, school administrators, local community leaders, and policy makers at every level of government. Together, we can give future generations of children the mathematical tools they need to make a living and to make a life.

Stuart Moskowitz

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Resources

The following resources may assist you in communicating to various community groups the changes taking place in mathematics education.

Counting on You. Actions Supporting Mathematics Teaching Standards
1991. $2.95. National Academy Press. 2101 Constitution Avenue, NW. Box 285. Washington, DC 20055; (800) 624-6242.

Everybody Counts: A Report to the Nation on the Future of Mathematics Education
1989. $8.95 plus $4 shipping and handling. 32 pp. National Academy Press. 2101 Constitution Avenue, NW. Box 285. Washington, DC 20055; (800) 624-6242.

Family Math
$18.00. Lawrence Hall of Science. Discovery Corner. University of California. Berkeley, CA 94720; (510) 642-1910.

Helping Your Child Learn Math
For Bulk orders only: 10 for $5 from D.C. Heath & Co., 2700 North Richardt Avenue. PO Box 19309 Indianapolis. IN 46219; (800) 334-3284. Order Code 31452-8. Fax (800) 824-7390.

They're Counting on Us
1995. Free sample copy. Developed by the California Mathematics Council. To order contact: National Council of Teachers of Mathematics. Dept. I. 1906 Association Drive. Reston, VA 20191-1593; (703) 620-9840 ext. 113; or e-mail at infocentral@nctm.org.

NCTM is pleased to make additional copies of *Mathematics: Making a Living, Making a Life* (stock #627) available to you and your organization or school. For fast service, call NCTM toll-free at (800) 235-7566 or (703) 620-9840 ext. 350.

Prices:

Number of copies (minimum order is 10 copies)	Price per copy
10–49	$1.30
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100 or more	$1.00

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Phone orders only 800-235-7566 or by E-mail at orders@nctm.org

Thank you for your support of mathematics education.

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